# THE RÔLE OF INSECTS IN THE PROPAGATION OF DISEASE

By JOHN H. McCOLLOM, M.D.

**Instructor in Contagious Diseases, Harvard University, Medical Department; Resident Physician South Department, Contagious Service, Boston City Hospital**

The statements regarding malaria and yellow-fever, while conclusive from an experimental point of view so far as the mosquito as the bearer of disease is concerned, were made many years ago based on a theoretical point of view. In 1807 Dr. John Crawford published a paper in the Baltimore *Observer* entitled "The Mosquital Origin of Malarial Disease." * In 1848 Dr. Josiah Nott, of Mobile, Ala., wrote a paper on yellow-fever in which he advanced the theory of the mosquito as the cause of the disease.† Dr. Finlay, of Havana, Cuba, in 1881 considered the possibility and strong probability of the transmission of yellow-fever by the mosquito.‡ The most comprehensive article on this subject from the theoretical side is that of Professor A. F. A. King, M.D., on "Mosquitoes and Malaria" in the *Popular Science Monthly* of September, 1883, vol. xxiii., No. 5, page 644 et seq. Professor King's theory was based on the following facts:

"1. Malaria affects, by preference, low and moist localities,—in fact, swamps, fens, jungles, and marshes. This statement no one will dispute.

"2. Malaria is hardly ever developed at a lower temperature than 60° F. A temperature of 60° F. is necessary for the development of the mosquito.

"3. The evolution or active agency of malaria is checked by a temperature of 32° F. The mosquito is killed or paralyzed, so that its active agency is checked, by a temperature of 32°.

"4. Malaria is most abundant and most virulent as we approach the equator and the sea-coast. The swarms of mosquitoes (as well as of sand-flies, ants, and other insect plagues) that infest many equatorial regions are well-known, and with regard to sea-coasts the accumulation of mosquitoes is both a fact and easily susceptible of explanation.

"5. Malaria has an affinity for dense foliage, which has the power of accumulating it when lying in the course of winds blowing from malarious localities.

---

* "Mosquitoes and Malaria," by A. F. A. King, M.D., *Popular Science Monthly*, vol. xxiii., No. 8, page 646.

† Ibid., page 645.

‡ Ibid., page 644.

" 6. Forests or even woods have the power of obstructing or preventing its transmission under these circumstances.

" 7. By atmospheric currents, malaria is capable of being transported to considerable distances, probably as far as five miles; so, certainly, is the mosquito.

" 8. Malaria may be developed in previously healthy places by turning up of the soil, as in making excavations for the foundations of houses, tracks for railroads, and beds for canals.

" 9. In proportion as countries previously malarious are cleared up and thickly settled, periodical fevers disappear.

" 10. Malaria usually keeps near the surface of the earth; it is said to 'hug the ground' or 'love the ground.'

" 11. Malaria is most dangerous when the sun is down, and it seems almost inert during the day.

" 12. The danger of exposure after sunset is greatly increased by the person exposed sleeping in the night-air.

" 13. In malarial districts the use of fire, both in-doors and to those who sleep out, affords a comparative security against malarial disease.

" 14. The air of cities in some way renders the poison innocuous, for, though a malarial disease may be raging outside, it does not penetrate far into the interior.

" 15. Malarial diseases are more prevalent towards the latter part of summer and in the autumn.

" 16. Malaria is arrested, not only by trees, walls, etc., but also by canvas curtains, gauze veils, and mosquito nets.

" 17. Malaria spares no age, but it affects infants much less frequently than adults."

So much for the theoretical side of the subject. If one carefully studies the different facts as given by King, one cannot fail to see that in each instance the conditions are such as are necessary for the development of the mosquito. For instance, malaria is most frequent in marshy localities, hence the common name for the disease is swamp-fever. Malaria is rare in cold weather, so is the mosquito. Residents in malarial districts have an inborn fear of night-air,—just the time when the mosquito is most active. In short, there seems to be no weak link in the chain of argument which King advances in support of his theory of the mosquito as the cause of the spread of malarial fever.

In 1885 Laveran published an account of a parasite found in the red blood-corpuscles of human beings ill with malarial fever. At about the same time Councilman described the life-history of this organism. It is now accepted by the medical world that this parasite, known as the plasmodium malariæ, is the cause of malarial fever, swamp-fever, intermittent fever, chills and fever, ague,—all these terms being synonymous. The cause of the disease having been discovered, it became a matter of interest to disclose the manner in which this organism finds its way into the blood of human beings, whether by the alimentary canal or by the respiratory organs. The number of different parasites, both animal and vegetable, which have been proved to be the cause of disease of greater or less severity in man is very great. Some of these parasites find their way into the system through the alimentary canal, others before they can gain an entrance into the system require an abrasion of the mucous membrane and the skin, of greater or less extent, and others still require an intermediate host, as is the case with the malarial protozoön. After the discovery of the protozoön was made and King's paper, to which allusion has been made, was written, physicians in different parts of the world simultaneously conceived the idea that the mosquito might be a factor in causing the prevalence of the so-called malarial fever. The terms malaria, malarial fever, and swamp-fever are now misnomers. The disease should be called by the comprehensive name of gnat fever, which gives an idea of the mode of its propagation. The experiments with mosquitoes have been so extensive and so varied that it must be accepted that the mosquito is the carrier of the plasmodium malariæ. The different varieties of mosquitoes is quite large, being something like twenty-five. The mosquito of the variety *Anopheles* is the one that conveys the protozoön; the *Culex,* which is the most common variety seen in this country, does not seem capable of transmitting the disease. The manner in which these two varieties rest on the wall of a house is extremely interesting and serves as a ready method of distinguishing them. The *Anopheles,* or malarial mosquito, appears as if standing on its head or with its body at an angle with the surface, whereas the *Culex* always assumes a hump-back appearance, and the main portion of the body is parallel with the wall. The genus *Anopheles,* or malarial mosquito, was classified and described in 1818, but, of course, at that time nothing was known of the plasmodium malariæ or of the agency of this insect in transmitting disease. Very few of us, without stopping to think, have any idea of the remarkable fecundity of the average mosquito. It has been estimated that the female under favorable circumstances will lay eggs in a single season which are represented by twenty-five figures. It is an interesting fact that the female *Anopheles* is the blood-sucker; the male does not drink human blood.

Not only has the plasmodium malariæ been found in the stomach of the mosquito, but there have been quite a number of experiments in which observers have lived for varying lengths of time in malarial districts without contracting the disease, being protected by means of mosquito nettings. For instance, there is the experiment of Fermi and Tonsini as described by Patrick Manson, M.D., in the *Practitioner* of March, 1901.* This experiment was conducted on the island of Asinara, an islet to the north of Sardinià, used as a convict station and lazaretto. The island is highly malarious, especially in its southern part.

" During the fever season it was ascertained that there were some six hundred or seven hundred square metres of stagnant water suitable as mosquito haunts. This water was treated twice a month with kerosene. Mosquito destruction was further attempted by burning culicicide powders in the dormitories of the convicts and in the cottages. All windows were protected with gauze. As a result of these measures it was almost impossible to find *Anopheles* in the houses, and other mosquitoes were much reduced in number as compared to former years. No fresh case of malaria occurred during the entire malaria season, from June to November. During the previous season there were forty cases of infection contracted on the island."

" Grassi's experiment as described by the same writer was conducted on the railway, which for twelve kilometres runs through the intensely malarial plain of Capaccio, which is so unhealthy during the fever season that all inhabitants except those employed on the railway leave for a time. On this section of line there are two shunting cottages and two stations. They were inhabited by one hundred and four persons, including thirty-three children. Of these one hundred and four individuals, with the exception of eleven, all had suffered from fever in previous seasons.

" Grassi subjected all who during the non-malarial season had shown signs of previous infection to active quinine treatment. The entire number were provided with wire-gauze protection from June to October. They were enjoined to retire into their protected houses at sunset and to remain there till sunrise. Those who went on duty during the night were provided with thick cotton gloves and veils.

" Notwithstanding the treatment with quinine, a gramme every seven days, twenty-seven individuals had relapses of their previous infections, namely, six in March, sixteen in April, six in May, seven in June, one in July, and one in September. The fever season began about the end of June, a case occurring in an unprotected man in the neighborhood of the railway.

" Of the one hundred and four protected individuals, with the exception of three instances which might very well have been recrudescences of previous infections, all remained immune; whereas of twenty-five people in cottages just outside the protected area, notwithstanding prophylactic treatment with quinine, all got the fever, and in about three hundred individuals living on farms on elevated ground only five escaped, and these, there was reason to believe, had from repeated infection acquired relative immunity."

---

* " Ætiology, Prophylaxis, and Treatment of Malaria," by Patrick Manson, M.D., *The Practitioner*, March, 1901, vol. 66.

"A very striking experiment was that performed by Drs. Sambon and Low, of the London School of Tropical Medicine, in the Roman Campagna during the late summer and early autumn of 1900. They had constructed a comfortable little five-roomed wooden house about three hours' drive from Ostia, in one of the most malarious portions of the Campagna. The house was tightly built and was thoroughly screened. The experimenters lived in this house through the period when malaria is most prevalent. They took no quinine and no health precautions beyond the fact that at sundown each day they entered the house and remained there until daylight the next morning. Dr. Rees, of the London School, visited them and occupied the house with them for a portion of the time, and all three conducted laboratory work in one of the rooms, which was fully equipped for such a purpose, and led a busy and contented life. They visited the neighboring villages and investigated outbreaks of the fever in men and cattle. They received and entertained many visitors who were interested in the experiment. They turned indoors before six o'clock and then stood at the windows and timed the first appearance of *Anopheles,* which would come at a certain hour each evening and try to enter the screened windows and doors. As Dr. Rees expressed it, 'It must have been very tantalizing for them to be unable to get at us.' When the rains set in, every one said that that was the critical time of the experiment. The people in the surrounding country generally became feverish and ill, which meant simply that they were all full of malaria, and the chilling caused by the rain brought about an explosion of the fever. The experimenters, however, went out into the rain and got soaked to the skin, but their health remained perfect. Not the slightest trace of malaria developed in either of them; as above stated, the spot where the house was built was probably the most malarious one in the whole Campagna, and it was situated on the banks of one of the canals, which was literally swarming with *Anopheles* larvæ. The prevalent idea that the night air of the Campagna is in itself so dangerous was included in the experiments, and the windows were always left open at night, so that if the marsh air had anything to do with malaria, they would have contracted it."

"A check experiment was carried on at the same time. *Anopheles* mosquitoes which had been fed on the blood of a sufferer from malaria in Rome, under the direction of the Italian authority Bastianelli, were sent to London early in July. A son of Dr. Patrick Manson, the famous investigator who first proved the transfer of malaria by mosquitoes, offered himself as a subject for experiment and allowed himself to be bitten by the mosquitoes. He had never been in a malarious country since he was a child, but in due time was taken with a well-marked malarial infection of the tertian type, and microscopical examination showed the presence of numerous parasites in his blood." *

It has been shown theoretically by King in the earlier part of this paper that malaria was transmitted by mosquitoes; it was demonstrated by means of experiments on human beings that the mosquito was the cause of the disease; it has been demonstrated by the microscope that the protozoön of malaria is found in the stomach of the *Anopheles;*—therefore the proof seems conclusive that the mosquito is the cause of the disease called malarial fever, but which should be named gnat fever.

A second disease much more fatal than gnat fever, a disease which is known under the names of yellow-fever, bronze John, yellow Jack, vomito prieto, and which prevails most extensively in warm climates and is frequently epidemic there, has also been demonstrated, both theoretically and experimentally, to be due to the bite of the infected mosquito. In 1886 Dr. Charles Finlay, of Havana, Cuba, advanced the theory that mosquitoes could convey the contagium of yellow-fever, and to him must be given the credit of inducing the subsequent investigations.

The following account of an outbreak of yellow-fever in St. Nazaire, France, which could be traced directly to Havana is extremely interesting and forms the basis of Dr. Finlay's mosquito theory. This is so interesting and so conclusive that a portion of Dr. Finlay's paper is quoted verbatim. He says as follows:

"The Anne-Marie, a wooden vessel with a crew of sixteen men, sailed from Nantes (France) for Havana, where it arrived May 12, 1861. During the thirty days that the vessel remained in Havana none of the men experienced any illness beyond 'malaise,' fatigue, loss of appetite, or inclination to vomit. She left Havana for Saint Nazaire (France) on June 13 with the same crew. At the start she remained twelve days becalmed in the Florida canal, with suffocating heat, frequent squalls, and heavy rains. On July 1 two fatal cases of yellow-fever and another (not fatal) the next day declared themselves on board. Two days passed without any new case, and then followed a series of six new invasions between July 4 and 8, none of them fatal, the last being the captain, whose attack was less severe, but was attended with a long and tedious convalescence. One, at least, of the other men, the mate, was certainly susceptible to the disease, and yet no other case occurred during the voyage. The vessel reached Saint Nazaire on the 25th of July and was brought to the wharf, where she lay alongside of the Arequipa, another vessel then ready to sail for Cayenne (French Guiana). The captain of the Anne-Marie had left the ship to attend to his health, and the mate remained in charge of the vessel, while the rest of the crew got their discharge on reaching Saint Nazaire, none of the men having taken the infection, as far as could be afterwards ascertained. The unloading of the cargo was, therefore, accomplished exclusively by new men under the mate's supervision. The hold was opened on July 27, and the unloading ended on August 3. The vessel, having been declared infected, was removed to the centre of the dock on the 5th and towed out into the open bay on the 7th, to be thoroughly disinfected. From the moment when the hold was thrown open all the susceptible persons who entered it became infected with fatal yellow-fever. On the 27th and 28th the cooper, who went down to inspect and repair damaged sugar-boxes, the mate, and also five sailors belonging to another vessel who had gone into the hold from curiosity and picked out some sugar-cane which was stowed between the boxes, all were attacked with yellow-fever and a few days later died. Altogether, between July 27 and August 5 nineteen persons who visited the hold or the deck of the Anne-Marie became infected with yellow-fever. Five other persons appear to have caught the infection from the wharf or on the deck of other vessels in close proximity to the infected ship. Two persons in the town received their infection, apparently, through bundles that were taken to them directly from the Anne-Marie. A remarkable case was that of Dr. Chaillon, who never came to Saint Nazaire at all, but on August 5, 6, 7, 10, and 11 had visited at their homes, in villages two or three miles distant from the port, four of the workmen who had been employed in the unloading of the Anne-Marie. He was taken sick with yellow-fever on the 13th and died on the 17th. This was the only second-hand infection that occurred during that epidemic on shore. More remarkable still was the case of Bruban, a stone-cutter, who never came to the side of the dock where the infected vessel was lying, nor had any communication (directly or indirectly) with it. He happened to be employed in repairs near the dock-gates while the Anne-Marie was being unloaded at a spot distant two hundred and twenty-five metres from that ship. He was taken sick on August 4 and died of yellow-fever on the 10th. Finally, the Arequipa, which had been lying alongside of the Anne-Marie since July 26, sailed on August 1 for Cayenne (French Guiana). Her mate, having apparently caught the infection from the Anne-Marie, was taken sick at sea on the 5th and died on the 12th. A new focus of infection seems then to have developed on board the Arequipa, for a series of invasions occurred on August 22 and 26, and September 9, 19, and 20, on her way to Cayenne, where the vessel arrived on October 8.

---

* "Mosquitoes: How they Live; How they Carry Disease; How they are Classified; How they may be Destroyed," by L. O. Howard, Ph.D., Department of Agriculture, Washington.

"The explanation of the above occurrences, according to my mosquito theory, would be as follows:

"The Anne-Marie, when she left Havana on June 13, must have had three of her crew recently infected with the disease, the same who were taken sick on July 1 and 2. During the operations of taking in cargo, provisions, and especially drinking-water, it is next to impossible that at that season of the year a considerable number of mosquito eggs and larvæ should not have been introduced on board. With the calms, hot weather, and rains that followed a whole brood of new mosquitoes must have been produced on board of the Anne-Marie by the time when the first cases of yellow-fever declared themselves; the young insects by stinging those patients became contaminated, and some of them must have transmitted the disease to the next six men who were attacked, with a milder form, between July 4 and 8. At the time when these six men took their infection the calms had ceased and the vessel was moving more rapidly and had reached cooler latitudes, which circumstances (beside the attraction of the sugar) must have induced the mosquitoes to seek refuge in the hold, entering it through chinks which were afterwards found to exist between the hold and the quarters which the sick men had occupied. During the rest of the voyage the contaminated mosquitoes would be feeding on the sugar and sugar-cane, while the yellow-fever germs were multiplying upon their stings (?) and attaining their highest degree of virulence until the hold was opened on July 27. The contaminated insects then commenced their yellow-fever inoculations upon all the non-immunes who came within their reach by entering the infected hold. The temperature at Saint Nazaire from July 26 to August 4 gave daily maxima between 69° and 77° F. (the latter only on August 1) and minima between 53° and 63° F., from which it must be inferred that the mosquito would leave the hold or fly out on deck or in the immediate vicinity of the Anne-Marie only during the hotter hours of the day; at other hours they would be benumbed in the open air, and might easily be conveyed in bundles or packages carried from the ship to their homes by the workmen employed in the hold. At the same time the range of temperatures was such that the reproduction of new generations of '*Culex* mosquitoes' could not take place, so that all the yellow-fever inoculations at Saint Nazaire must be attributed to mosquitoes which had become contaminated on board of the Anne-Marie on July 1 or 2 (at any rate, within the first week of that month). The extreme term of existence for that species of mosquito being reckoned at from thirty-five to forty days, the youngest contaminated mosquitoes imported by the Anne-Marie should have died within the second week of August; in point of fact, no instance of infection occurred at Saint Nazaire that could be attributed to a later date. Dr. Chillon's case may be explained on the supposition that some contaminated mosquitoes, accidentally conveyed by the workmen returning to their homes, had stung the unfortunate doctor; those insects, however, having reached the natural term of their existence, would have been unable to continue the propagation of the infection. The case of the stone-cutter may be accounted for by admitting that at the midday hours some of the contaminated insects while flying over the deck may have been blown away by some gust of wind towards the water of the dock; in order to save themselves from drowning, they would have alighted upon any object floating on the water, which, drifting with the outflowing current, must have landed them close to the gate where the stone-cutter was working. The case of the Arequipa is instructive as showing how the climatic conditions on that vessel, arising from the fact that it happened to be travelling towards the tropical regions, must have enabled new broods of the *Culex* mosquito to develop so that a secondary focus of infection was originated, whereas at Saint Nazaire the prevailing temperatures prevented the occurrence of this event. According to my theory, some of the mosquitoes, free from contamination, must have passed from the Anne-Marie to the Arequipa before the latter moved away from the side of the infected ship; they probably laid their eggs in some water-tank, and communicated the disease from the mate to the next patient who followed (and died); a new brood of *Culex* mosquitoes must have developed during the voyage, and some of them, having found their way to the patients, occasioned the subsequent invasions of that vessel." *

So much for the theoretical side of the question. The results of the experiments in Havana with mosquitoes infected with yellow-fever are as conclusive as with those with malarial fever, with the exception that as the organism causing yellow-fever has not been discovered, it was impossible to find it in the stomach of the mosquitoes. Howard in his work on mosquitoes gives the following account:

---

* "The Mosquito Theory of the Transmission of Yellow-Fever, with its New Developments," by Charles Finlay, M.D., Havana, Cuba, *Medical Record,* January 19, 1901, vol. 59, No. 3.

"An experimental sanitary station was established in an open, uncultivated field about one mile from the town of Quemados, Cuba, under the complete control of Major Reed. The station was named Camp Lazear, in honor of the brave physician who went to his death in the early summer of 1900. A most careful series of experiments was carried on to see whether yellow-fever can be conveyed by fomites, that is, by personal contact with the clothes or belongings of yellow-fever patients. As is well-known, the consensus of opinion, both of the medical profession and of others, is in favor of the conveyance of yellow-fever in this way, and every effort is made to disinfect clothing and bedding shipped from ports where yellow-fever prevails. All articles of personal apparel are subjected to disinfection, and, as everyone knows, during a time when the fever is epidemic in any of our Southern States even the mails are disinfected before being allowed to go North. There was further erected at Camp Lazear a small frame house with a cubic capacity of twenty-eight hundred feet, tightly ceiled and battened, provided with small windows, so as to prevent a thorough circulation of air through the house, and with wooden shutters to prevent the disinfecting qualities of sunlight. The windows were closed by permanent wire screens with a five-millimetre mesh. The vestibule was protected by a solid door and a wire-screen door, and the inner entrance by a second wire-screen door. In this way the passage of mosquitoes into the room was effectually excluded. The average temperature was kept at 76.2° F. for a period of sixty-three days, and precaution was taken to maintain sufficient humidity of the atmosphere. On November 30 three large boxes filled with sheets, pillow-slips, blankets, and so on, contaminated by contact with cases of yellow-fever and their discharges, were received and placed in the room. Most of these articles had been taken from the beds of patients sick with yellow-fever in Havana. Many of them had been purposely soiled with the excretions of patients. These soiled sheets, pillow-cases, and blankets were used in preparing the beds in which the members of the Hospital Corps slept. During sixty-three days this building, thus furnished, was occupied by seven non-immune persons. Three of them occupied the room each night for twenty days. Later a fourth box of clothing and bedding was added, some of it purposely soiled with the bloody stools of a fatal case of yellow-fever. Two of them occupied beds from December 21 to January 10 every night, wearing the very garments worn by yellow-fever patients throughout their entire attacks, making use exclusively of their much-soiled pillow-slips, sheets, and blankets. At the end of twenty-one nights they went into quarantine (as had the former three) and were released five days later. Two other non-immunes occupied the same beds for twenty days more. The attempt, therefore, which was made to infect this building and its seven non-immune occupants during a period of sixty-three days was an absolute failure; all seven were released from quarantine in excellent health.

"A precisely similar building was erected at Camp Lazear, which was known as the infected mosquito building. The door and windows were placed on opposite sides of the building so as to give a thorough ventilation. It was divided into two rooms by a wire-screen partition extending from floor to ceiling. All articles admitted to the building were carefully disinfected by steam before being placed therein. Into the large room of this building mosquitoes which had previously been contaminated by biting yellow-fever patients were admitted. Non-immunes were placed in both rooms. In the room in which mosquitoes were not admitted the experimentalists remained in perfect health. In the other room six out of seven persons bitten by infected mosquitoes came down with yellow-fever. In all, of persons bitten by infected mosquitoes that had been kept twelve days or more after biting yellow-fever patients before being allowed to bite them, eighty per cent. were taken with the disease.

"The conclusions reached after this careful experimentation have been summarized under eleven heads, as follows:

"1. The mosquito—C. fasciatus—serves as the intermediate host for the parasite of yellow-fever.

"2. Yellow-fever is transmitted to the non-immune individual by means of the bite of the mosquito that has previously fed on the blood of those sick with this disease.

"3. An interval of about twelve days or more after contamination appears to be necessary before the mosquito is capable of conveying the infection.

"4. The bite of the mosquito at an earlier period after contamination does not appear to confer any immunity against a subsequent attack.

"5. Yellow-fever can also be experimentally produced by the subcutaneous injection of blood taken from the general circulation during the first and second days of this disease.

"6. An attack of yellow-fever produced by the bite of the mosquito confers immunity against the subsequent injection of the blood of an individual suffering from the non-experimental form of this disease.

"7. The period of incubation in thirteen cases of experimental yellow-fever has varied from forty-one hours to five days and seventeen hours.

"8. Yellow-fever is not conveyed by fomities, and hence disinfection of articles of clothing, bedding, or merchandise supposedly contaminated by contact with those sick with this disease is unnecessary.

"9. A house may be said to be infected with yellow-fever only when there are present within its walls contaminated mosquitoes capable of conveying the parasite of this disease.

"10. The spread of yellow-fever can be most effectually controlled by measures directed to the destruction of mosquitoes and the protection of the sick against the bites of these insects.

"11. While the mode of propagation of yellow-fever has now been definitely determined, the specific cause of this disease remains to be discovered." *

Flies, while they do not communicate yellow-fever or malarial fever, may communicate typhoid fever in the following way. Flies feeding on the intestinal discharges of typhoid-fever patients light upon articles of food, such as bread and fruits, and in that way may communicate the disease. While there are no direct experiments to prove this point, it is reasonable to suppose that many unexplained attacks of typhoid fever may be communicated in this way. It is therefore important to carefully disinfect all typhoid-fever stools.

The reclaiming of marsh lands should be done whenever possible. The immense areas of marsh lands near all seaboard cities is a matter of common knowledge. Professor Shaler estimates that between New York and Portland there are two hundred thousand acres of marsh lands which are the breeding-places of immense numbers of mosquitoes. Not only are these extensive marshes breeding-places of mosquitoes, but small pools, water-tanks, and gutters are also favorite places for depositing the eggs of the insect. It has been stated that mosquitoes do not breed in salt marshes. This is incorrect, for salt water or sea water, in the proportion of one part salt to two parts fresh, is a favorite place for the mosquito to deposit her eggs. The reclaiming of these extensive districts is too great an undertaking to be accomplished in a short time, but small areas of water and a limited extent of marshy land can be freed from mosquitoes by means of kerosene. The small pools of water about many houses, particularly in the country, can be rendered innoxious, so far as the mosquito is concerned, by a very limited outlay of time and money, with kerosene oil. Houses in which mosquitoes are abundant can be freed by wiping the walls with a small amount of kerosene, particularly the basements, where mosquitoes remain during the daytime and hibernate.

It is very important that all small pools of water should be treated

---

* "Mosquitoes: How they Live; How they Carry Disease; How they are Classified; How they may be Destroyed," by L. O. Howard.

with kerosene, for these small collections of water seem to be the favorite breeding-places of this insect.

Chlorine gas can also be used to kill mosquitoes in houses. Fermi and Lumbao, according to Howard, recommend the following procedure: four or five spoonfuls of chloride of lime are put into a common dinner-plate and five to ten cubic centimetres of crude sulphuric acid poured over it. This liberates chlorine gas, which kills the mosquitoes. Cones made of pyrethrum powder burned in a room where there are mosquitoes will cause their death. Howard advises the use of tin-cups or inverted can-covers as follows:

"The use of tin-cups or inverted can-covers, the shallower the better, nailed to the end of a stick and containing a very small quantity of kerosene, is very prevalent in some parts of the country for catching mosquitoes resting on the ceiling. Where the ceiling is white, the mosquitoes can readily be observed and the tin-cup is pushed up under them. When they attempt to fly they are caught by the kerosene and killed. I have seen dozens of them caught in this way of an evening in a mosquito-infested house."

In fact, any of the essential oils, more particularly the oil of citronella, will keep away mosquitoes for a limited time. The only effectual method, however, of keeping mosquitoes out of a house is by the use of screens in the windows and doors. While in the Northern States there may be very little chance of contracting gnat fever and yellow-fever, the annoyance to patients from mosquitoes and flies is very great, and therefore every hospital and every room in which there are patients ill with acute diseases should be carefully screened. While the nurse may for the time being diminish the number of these pests by the measures advised, yet she cannot accomplish as much as can be done by screens. If it is impossible to screen the windows and doors, a canopy can be placed over the bed, but this is frequently a source of annoyance to the patient.

While there is no positive proof that scarlet-fever, measles, and small-pox may be communicated by insects, yet it is the part of caution to protect patients ill with these diseases from these pests.

As it is the duty of the nurse, in addition to the carrying out of the directions of the physicians, to render her patients as comfortable as possible, she must be considered as failing in the performance of her duties if she allows mosquitoes and flies in the sick-room. I know perfectly well that the exclusion of insects from the sick-room is a very difficult thing, but by patience and perseverance this can be accomplished, and the nurse who does accomplish it is a better nurse than the one who fails to accomplish it.